NETWORK ELEMENT LOCATING SYSTEM

Field of the Invention

The invention resides in the field of optical telecommunications networks, and is directed in particular to a network element locating system

Background of the Invention

Modern networks are comprised of heterogeneous network elements (NEs), the physical connections between the NEs, and the software used to send, receive and route data. As competition among telecommunications vendors has grown, so has the size, complexity of modern communications networks. These complex communications networks, which may span thousands of miles of territory, can, and frequently do, contain thousands of different network elements of various types, made by different manufacturers, and using different communications protocols.

Managing these large and complex networks presents substantial challenges. It is known to provide the network with a centralized network management tools, which collects real time information regarding the status of the network elements and systematize this knowledge such that common problems can be detected, isolated and repaired, either automatically or by the maintenance personnel. The intent of the network management tools is to facilitate the management of the network elements by providing a centralized view of the network, as well as to enable correlation of events and conditions that span the network elements and sub-networks.

An important aspect of a network management system (NMS) is the way this information is presented to the user and the degree of interaction permitted between the user and the network, in other words, the network-user interface. In general, the user interface resides at the client terminal and is adapted to communicate with the reminder of the system. Network information is presented on a screen (graphical user interface or GUI) using icons, and the user has the ability to select additional information about a particular object model, including object models of network equipment and connectivity between the equipment, hopefully in a clear and well-organized, condensed way.

However, only certain problems may be fixed from the network management site, such as shutting down an overheating element, or rerouting traffic away from a malfunctioning network element. More often, maintenance crews need to be deployed at the site of the fault. One of the most fundamental challenges in such a scenario is the identification and accurate representation of the condition (or state) of the network. Equally important is to determine the geographical location of the faulted network elements with as much as possible accuracy, so that the maintenance crew can be promptly deployed at the respective site.

Currently, the identity of all network elements is manually entered at installation. Consequently, when a network element is either added or deleted, each of the elements would have to be manually updated with the identity of the element or elements being added or deleted. Additionally, when adding a network element, all the identity information of the other elements in the network would have to be manually inputted into the new network element. Such manual inputting of the identity information into the network elements is not only time consuming, but prone to errors. Another shortcoming of the existing network management systems is that physical records of the network element identity information had to be maintained in order to know the configuration of the network elements.

Some network management systems use bitmap background maps which provide a general view of the network element placement (geographical position) and connectivity. In order to show the position of the network elements on a bitmap, every NE needs to be positioned manually on such maps, which is not an easy operation. Also, the icon for each NE needs to be anchored to the map to avoid any undesired displacement on the map. These maps are not standardized and often very rudimentary, giving an approximate address for the nodes (sites), and no specific address for the network elements themselves.

Furthermore, when a new user workstation is provided, the setup has to be saved and ported to the new user manually. As indicated above, these setup procedures are time and labor consuming, leading to an increase in overall installation and setup time, which is not acceptable to most users.

Another disadvantage of the bitmaps is that they require a large memory area.

In addition, the current NMS's are not provided with zoom-in/out capabilities, so that it is not possible to obtain position details on the bitmaps.

Summary of the Invention

It is an object of the invention to provide network element positioning and tracking system for managing position information of network elements, which obviates or mitigates at least one of the disadvantages of the existing systems.

In accordance with an aspect of the invention, there is provided a network element locator for a network element (NE) of a communication network. The network element locator comprises means for storing position data reflecting the current geographical location of said NE; and means for transmitting said position data over said network in response to a request for position reporting.

In accordance with another aspect of the invention, there is provided a network element position manager for a communication network of the type having a user-network interface for monitoring and controlling a plurality of network elements (NEs) of said network. The position manager comprises means for transmitting a position information request over said network; and means for converting said position data into user-format position information.

In accordance with another aspect of the invention, there is provided a method for specifying the position of a network element in a communication network. The method comprises storing position data of said network element at said network element (NE); transmitting said position data to a remote location on request; specifying a user-formatted information for reporting said position data; and providing said position data to said user as said user-formatted information.

Advantageously, the invention enables efficient management of position information of network elements, and allows users to easily locate the network elements. The system also provides real time information on the location of a faulty network element for allowing fast deployment of the maintenance crews for repair/replacement.

The system of the invention can be applied to any non-mobile piece of equipment such as transport equipment, metro equipment, access equipment, digital subscriber line (DSL) modems, etc. The term "network element" of a communication network also includes such non-mobile pieces of equipments in the context of the purpose of the invention.

The position information can be provided as a text file, or/and on a digital map. The information may also include directions to the site of the network element in question.

In addition, if a network element is removed for repair and is thereafter re-connected into the network, the position data for the respective NE is automatically updated to indicate the new location.

Other aspects and features of the present invention will be readily apparent to those skilled in the art from a review of the following detailed description of preferred embodiments in conjunction with the accompanying drawings.

Brief Description of the Drawings

The foregoing and other objects, features and advantages of the invention will be apparent from the following description, as illustrated in the appended drawings, where:

Figures 1A and **1B** are examples of digital maps showing the location of a network element on the US map of Figure 1A, and on the city map of Figure 1B;

Figure 2 is a block diagram of the network element locating system; and

Figure 3 is a flowchart showing operation of the network element locating system.

Detailed Description of the Preferred Embodiments

Figures 1A and 1B are examples of digital maps showing the location of a network element (NE) on the US map in Figure 1A, and on the city map in Figure 1B. The digital maps used by the NE locating system could be for example from Microsoft Trips and Streets application or the like. This type of maps offers world-wide scalability, which alleviates the need for multiple separate bitmaps. They also offer zoom in/out capabilities, giving for example country-level details within a country/continent, as shown in Figure 1A, or details at street level granularity, as shown in Figure 1B.

Furthermore, these digital and vector maps can be used on any platform and any terminal, so that no specific set-up is necessary. Additional service can

be provided using the inherent driving directions capability that some of these applications have.

Figure 2 is a block diagram of the network element locating system in accordance with an embodiment of the present invention. This figure illustrates a network element locator **10**, provided at a network element (NE), and a location manager **20**, part of the network management system (NMS). It is to be understood that only the units pertinent to detecting the network element geographical position are shown on this figure, other units related to traffic transmission/ reception at the NE and NMS sides are not the object of the invention and therefore are not illustrated. It is also to be noted that Figure 2 shows only one network element locator **10;** similar configurations may be used for all network elements controlled by network management system.

Each network element stores its geographical location information in a management information database (MIB) **18**, inherently present at all managed objects of a network. Alternatively, a dedicated register may be used for this information, but the MIB variant is preferable. The geographical location information is stored as position data, and may include any information that fully identifies the location of the network element. Thus, in the case when the site is in a populated area, the position data may include the postal address, or otherwise, it can include the country, county, and/or the geographical coordinates (e.g. in the case of optical amplification huts). Furthermore, the position data may include rack and shelf location of all card-packs of the network element.

The current geographical position information of network element locator **10** can be obtained using a geographical position detector **30** during installation of the network element at the respective site. This could be for example a GPS (geo-positioning system) hand-held device, which is readily available at an acceptable price (less than $100). As NEs are stationary, geographical position detector **30** can be portable, and carried by the crew installing the NE.

Alternatively, device **30** can be built-in the NE locator **10**; this option will not increase the cost of the NE by much, but will provide the NE with means for automatically updating the position data whenever the NE is moved to another location. The geographical position information can alternatively be entered manually, as shown at by input/output terminal **40**.

In general, all network elements are provided with interfaces as shown at **11** for setting some NE provisioned parameters. This interface can also be used for entering the position data into memory **18** from device **30** or/and **40**.

The position data is maintained in the database **18** until the network element locator **10** is removed from the network, for example in the case that it is removed for repair. If thereafter the NE having NE location manager **10** is deployed at another site, the new position data will be entered during installation at that site.

Modern networks are provided with a signaling and control layer that enable data communication between the network elements and the network management system. The data transmitted over this network from the NE locator **10** to NE location manager **20** are for example device alarms, and the data transmitted from the NMS to the NEs are control signals. Different manufacturers frequently use different protocols and commands for managing their network elements, such as Q3, TL-1 or SNMP. To enable this signaling and control communication, the network elements are provided with a dedicated transceiver (a transmitter/receiver pair), as shown at **14**. Thus, the position data can be multiplexed with the signaling and control data and transmitted from the network element locator **10** to NE location manager **20** over the control and signaling network **15**, using transceivers such as **14**.

On the transmit side of transmitter **14**, unit **16** controls position data transfer between the database **18** and the transmitter side of transceiver **14**. On the receive side, controller **16** detects a request for position identification received from the NE location manager **20** and operates the NE to extract the position data from database **18** and prepare it for transmission. Alternatively, the NE **10** may automatically transmit its position data whenever the NMS connects to it. Still further, the position data may be sent automatically whenever the NE issues specific types of alarms. The alarm information sent to NMS can also contain the position data. Controller **16** also instructs position detector **30** to establish the geographical position of the NE for the built-in variant. Such a request can be issued automatically whenever the NE is powered-up. Other events can be setup to trigger position data collection. Controller 16 may be provided with one or all of the above options.

At the NMS side, the reverse operations are taking place. Namely, the receiver side of a transceiver **24** detects the position data received from NE **10**, and a position display manager **22** provides it to the user-network interface UNI **28**. The display manager **22** processes the data to present it in an appropriate format on graphical user interface (GUI) **50**, also called here as user-format position information. As discussed above in connection with Figures 1A and 1B, the position data could be translated into an icon placed in the correct position on a digital map **5**, or may be presented as a text file indicating the position of the NE **10** on the screen or printed on a printer **6**. The user can zoom-in so as to obtain street-level details.

On the transmit side, controller **26** can be set to request the geographical location information at preset intervals, or in response to requests by the user, over UNI **28**.

Controller **26** invokes the digital map **5**. The digital map **5** is typically installed in the NMS. Alternatively, the NMS may retrieve the digital map **5** over the Internet to use Web services, such as Yahoo maps. Figure 3 is a flowchart showing operation of the network locating and tracking system. It shows the operations taking place at the NE side on the right side of the flowchart, and the operations taking place at the NMS side on the right side. Thus, the NE acquires the geographical location information, step **61**, using preferably GPS device **30**, or using a terminal such as a laptop/notebook **40** for manual input of this information and stores in memory **18** as shown at step **62**. NE locator **10** transmits its position data to NE location manager **20**, step **65**, whenever a request for position data is received, step **63**, or whenever the NE issues a specified type of alarm, step **64**. The position data may be stored in the memory **18**, until the network element is relocated in the network. The old position data, together with the reason(s) of re-location may be kept in the memory 18, for use in e.g. various statistics equipment inventory, etc.

Network element location manager **20** receives the position data, as shown in step **71**. The user sets the options on the GUI **50**, regarding e.g. the type of display for the position data, the amount of geographical position information to be presented, as shown in step **72**. One option is to show the NE on the map, in which case a digital map **5** is invoked in step **73**, and the position data is mapped

on the map, step **74**, and presented to the user, step **75**. If the user wishes to have the information in a text format, the NE location manager **20** may provide a printed version of the coordinates, which may include details such as a ZIP code, street number, floor, as shown in step **76**. If required, driving directions can be obtained as shown in step **77**.

It is to be noted that the position data can be presented to the user using other means, such as for example audio data. This can be also transmitted to the maintenance crew directly so that the crew is dispatched immediately in case of a fault. There are numerous other options to present this information; of importance is that the information on NE position is immediately available so as to be used as needed.